FREQUENCY OF OBSERVATION OF BIRD SPECIES IN SUB-COASTAL FARMLAND IN SOUTHEAST QUEENSLAND

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A farming district in southeast Queensland was surveyed from June 1980 to May 1985 to determine presence of bird species. Softwood scrub was the predominant vegetation before European settlement, but now occurs only in isolated remnant patches. Standard surveys were conducted on 20 days, one per season per year, and other surveys on another 100 days. The district supports a diverse and abundant avifauna: 44 waterbird, 60 non-passerine landbird and 88 passerine species.

Nearly 40% of waterbird and passerine species observed in standard surveys were observed in over 80% of them, but only 21% of non-passerine landbird species. In contrast, 45% of the latter species were observed on 20% or fewer visits, compared with 25% of the waterbird and passerine species. Frequency of several waterbird species was minimum in the wettest year, following widespread drought in southeast Australia.

Thirty species had large differences in mean seasonal frequency; some were summer or winter visitors. Approximate dates of presence are given. Rose Robin, Grey Fantail and Yellow-faced Honeyeater were present during well-defined winter periods, while Rufous Fantail and several other species were summer visitors. Scarlet Honeyeater and Spotted Pardalote were passage migrants.

The combination of standard and other surveys generated a robust database against which changes in relative abundance can, and should, be monitored to guide management. While an effective habitat mosaic remains for passerines and waterbirds, it appears less suitable for non-passerine landbirds other than doves and parrots which can be commensal with farming. Retention and better management of native woody vegetation may be essential to forestall decline in the avifauna with more intensive settlement. □ *Bird, farmland, habitat, remnant vegetation, seasonal movement, management.*

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Since European settlement, the vegetation of Australia has been progressively cleared and modified. This has led to decreases and actual losses of fauna and flora (Saunders, 1989; Hobbs & Hopkins, 1990; Recher & Lim, 1990; Saunders & Curry, 1990). Despite these changes, agricultural landscapes may be significant wildlife habitats (Breckwoldt, 1983, 1986; Saunders et al., 1987). Remnant vegetation along roadsides, for example, is used by many species of birds (Arnold & Weeldenburg, 1990; Cale, 1990; Saunders & de Rebeira, 1991; Leach & Recher, 1993).

Various workers have reported census data from avian communities in relatively undisturbed forest, woodland and heathland (e.g. Kikkawa, 1982; Pyke, 1983, 1988, Recher et al., 1985; Ford et al., 1985; Gosper, 1992; see also Keast et al., 1985; Ford, 1989). By contrast, information from highly modified landscapes is often anecdotal (e.g. Barnard, 1925; Lord, 1956) and comparisons of historical and present day abundances based on 'reporting rates' (Blakers et al., 1984) are insufficient for the needs of management because the data are compiled at too coarse a scale (Ford, 1989).

In this paper, we report five years of census data from the Marburg district, a subcoastal farming area of southeast Queensland. The district includes a diverse mosaic of habitats and is rich in bird species (Leach & Hines, 1987). The data concern (1) the relative abundances of bird species and (2) seasonal changes in their abundances. They provide a baseline that will permit assessment of future changes in the avifauna as land management practices alter or intensify.

English names for birds follow those of R.A.O.U. (1978).

STUDY AREA AND METHODS

The survey area

The survey area was the 10′ grid square centred on 27°35′S, 152°35′E (Fig 1a). Marburg is near the centre and Rosewood, with a population of

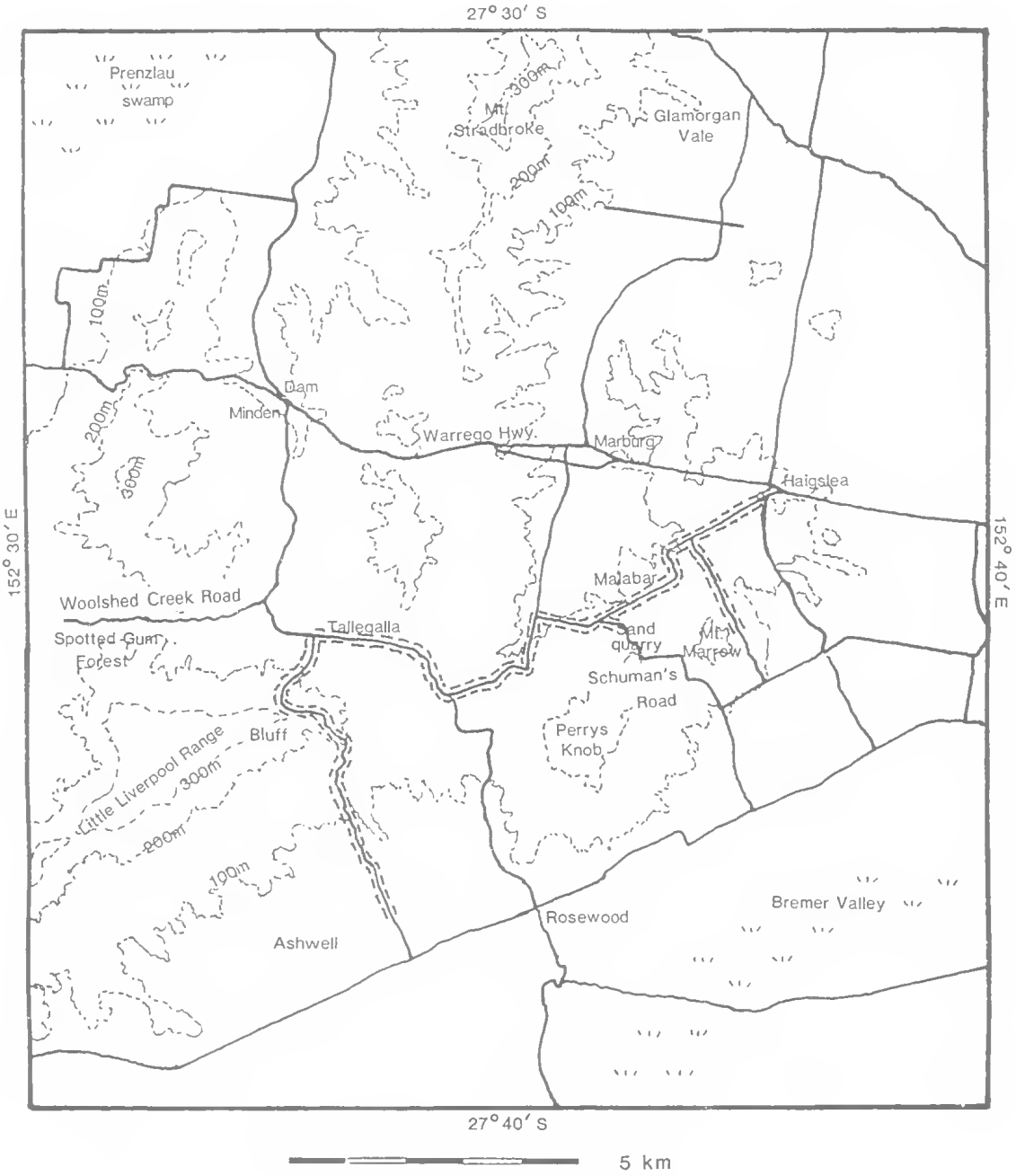
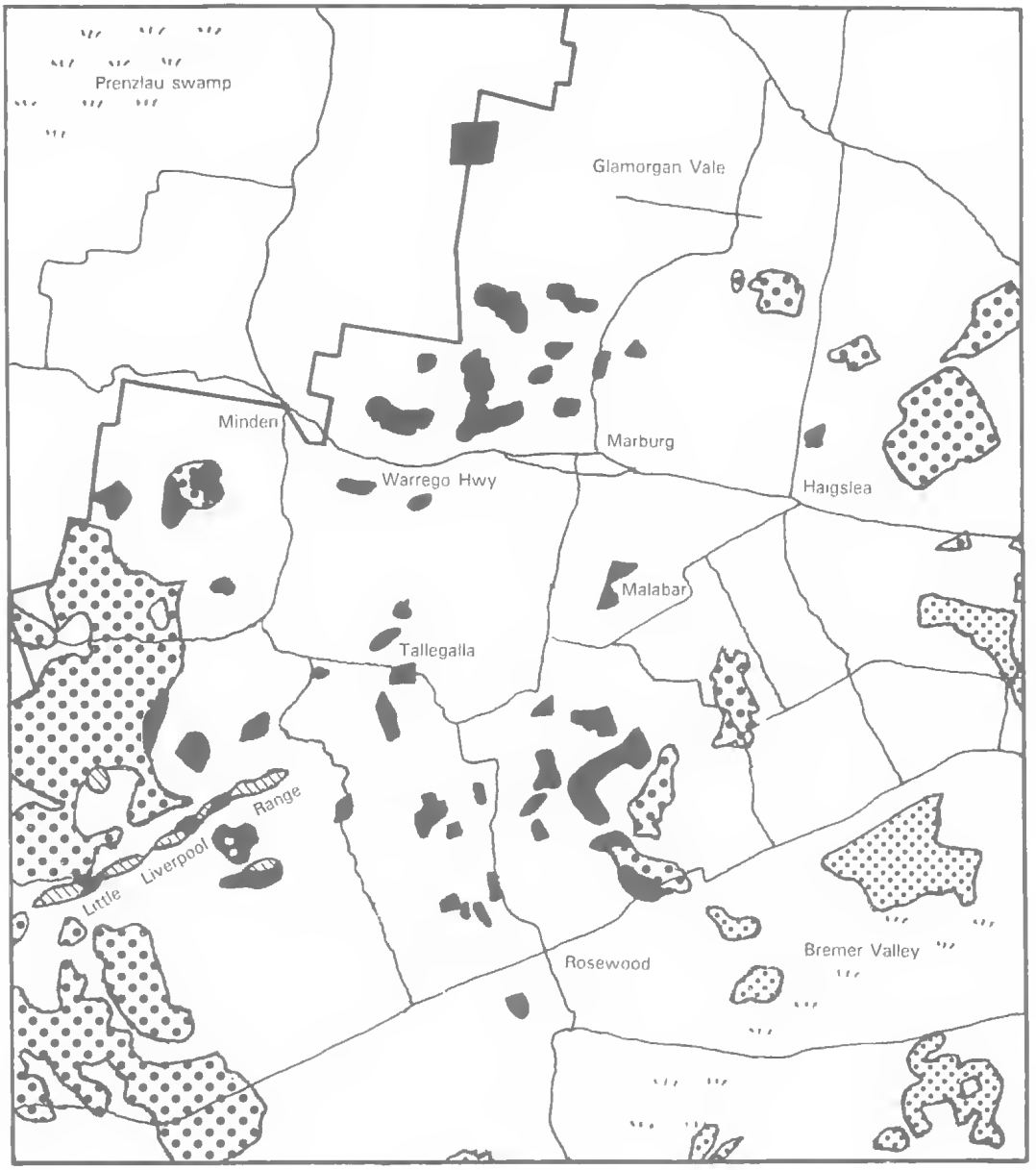


FIG. 1. The Marburg district showing (this page) the standard survey route (═══), physiography and other features mentioned in the text and (next page) remnants of forest and woodland vegetation in the area of the grid square within Moreton Shire (after Young, 1985, courtesy of P.A. Young and Moreton Shire Council). An equivalent map is not available for the area beyond the shire boundary (the heavy line in the north-west) but distribution of vegetation remnants through the landscape, excluding the ephemeral swamp at Prenzlau, is not markedly dissimilar. Note that the widespread narrow galleries of vegetation along roadsides and fencelines are not shown.



Brigalow-softwood closed-forest.

Softwood-Hoop Pine (*Araucaria cunninghamii*) closed forest.

Eucalypt open-forest (Spotted gum, ironbarks; Gum-topped Box, *E. moluccana*, northeast of Haigslea).

Eucalypt woodland (Blue Gum, *E. tereticornis*, and ironbarks).

TABLE 1. Mean seasonal frequency (MSF) in standard surveys, and mean annual frequency (MAF) in standard surveys and other surveys, for waterbird species. Species are tabulated in descending order of MAF first in the standard surveys and subsidiarily in other surveys. Seasons are: Wi, winter; Sp, spring; Su, summer; Au, autumn. Range, the difference between maximum and minimum annual frequency. Years, the number of years, in parentheses, in which species were observed.

Species	Standard surveys							Other surveys		
	Wi	Sp	Su	Au	MAF	Range	Years	MAF	Range	Years
Australasian Grebe	1.00	1.00	1.00	1.00	1.00	0.00	(5)	0.98	0.11	(5)
Pacific Black Duck	1.00	1.00	1.00	1.00	1.00	0.00	(5)	0.96	0.11	(5)
Dusky Moorhen	1.00	1.00	1.00	1.00	1.00	0.00	(5)	0.95	0.12	(5)
Cattle Egret	1.00	1.00	1.00	1.00	1.00	0.00	(5)	0.91	0.15	(5)
Little Pied Cormorant	1.00	1.00	1.00	1.00	1.00	0.00	(5)	0.86	0.07	(5)
Eurasian Coot	1.00	1.00	1.00	1.00	1.00	0.00	(5)	0.83	0.35	(5)
White-faced Heron	1.00	1.00	1.00	1.00	1.00	0.00	(5)	0.80	0.37	(5)
Masked Lapwing	1.00	0.80	1.00	1.00	0.95	0.25	(5)	0.92	0.15	(5)
Little Black Cormorant	0.80	1.00	1.00	1.00	0.95	0.25	(5)	0.82	0.26	(5)
Purple Swamphen	1.00	1.00	0.80	1.00	0.95	0.25	(5)	0.79	0.32	(5)
Grey Teal	1.00	0.80	1.00	0.80	0.90	0.25	(5)	0.58	0.36	(5)
Hardhead	1.00	1.00	1.00	0.60	0.90	0.25	(5)	0.53	0.56	(5)
Straw-necked Ibis	0.80	0.60	0.80	1.00	0.80	0.50	(5)	0.74	0.55	(5)
Black-winged Stilt	0.60	0.60	0.80	0.60	0.65	0.25	(5)	0.47	0.53	(5)
Royal Spoonbill	0.60	0.60	0.80	0.60	0.65	1.00	(4)	0.35	0.46	(5)
Black-fronted Plover	0.60	0.80	0.60	0.60	0.65	0.75	(5)	0.28	0.48	(5)
Intermediate Egret	0.80	0.60	0.60	0.40	0.60	1.00	(4)	0.56	0.37	(5)
Pacific Heron	0.80	0.20	0.60	0.40	0.50	0.50	(5)	0.42	0.42	(5)
Comb-crested Jacana	0.60	0.40	0.40	0.60	0.50	0.75	(4)	0.33	0.67	(5)
Sacred Ibis	0.20	0.20	0.60	0.80	0.45	0.75	(4)	0.46	0.47	(5)
Maned Duck	0.60	0.40	0.40	0.40	0.45	0.50	(5)	0.40	0.17	(5)
Plumed Whistling-Duck	-	0.60	0.40	0.60	0.40	0.75	(3)	0.34	0.46	(5)
Latham's Snipe	-	0.80	0.80	-	0.40	0.50	(4)	0.24	0.26	(5)
Great Egret	0.40	0.60	-	0.20	0.30	0.75	(3)	0.39	0.42	(5)
Yellow-billed Spoonbill	0.40	-	0.20	0.20	0.20	0.25	(4)	0.27	0.51	(5)
Darter	0.20	-	0.20	0.40	0.20	0.50	(3)	0.14	0.14	(5)
Red-kneed Dotterel	0.20	0.20	0.20	0.20	0.20	0.75	(2)	0.10	0.28	(3)
Pink-eared Duck	0.20	0.40	-	0.20	0.20	0.50	(3)	0.07	0.16	(4)
Glossy Ibis	-	0.20	0.20	-	0.10	0.25	(2)	0.19	0.56	(3)
Little Egret	0.20	-	0.20	-	0.10	0.25	(2)	0.05	0.17	(3)
Australian Pelican	0.20	-	-	-	0.05	0.25	(1)	0.13	0.19	(4)
Great Cormorant	-	-	-	0.20	0.05	0.25	(5)	0.02	0.06	(5)
Black Swan	-	-	-	-	-	-		0.19	0.61	(4)
Australasian Shoveler	-	-	-	-	-	-		0.10	0.33	(4)
Little Bittern	-	-	-	-	-	-		0.06	0.07	(5)
Rufous Night Heron	-	-	-	-	-	-		0.03	0.06	(3)
Sharp-tailed Sandpiper	-	-	-	-	-	-		0.03	0.16	(1)
Whiskered Tern	-	-	-	-	-	-		0.03	0.11	(2)
Black-necked Stork	-	-	-	-	-	-		0.02	0.06	(2)
Wandering Whistling-Duck	-	-	-	-	-	-		0.02	0.05	(2)
Chestnut Teal	-	-	-	-	-	-		0.02	0.11	(1)
Buff-banded Rail	-	-	-	-	-	-		0.02	0.05	(2)
Pied Cormorant	-	-	-	-	-	-		0.01	0.06	(1)
Painted Snipe	-	-	-	-	-	-		0.01	0.06	(1)

1657, is the main town. Physiography, vegetation and land use are described by Leach & Hines (1987). The landscape, of low hills (max elevation: 396m) and broad valleys, has been substantially cleared for agriculture, other rural use and residential occupation. There are creeks that flow intermittently, small swamps and numerous farm dams.

Fertile prairie soils and grey cracking clays are common. In the past they supported low closed-forest and brigalow (*Acacia harpophylla*)-softwood closed-forest which covered about half the survey area (Anonymous, 1974; Young, 1985; Hass, 1987; Young & McDonald, 1987; Elsol, 1991). We describe these two vegetation types as softwood scrub; remnants are now patchily distributed and occupy less than 4% of the area (Fig. 1b). Many of the remnants are substantially disturbed. Thin solodic soils on some low hilly terrain support open eucalypt forest (Spotted Gum, *Eucalyptus maculata*, and the ironbarks *E. crebra* and *E. melanophloia* are common); these associations now cover about 9% of the district.

WEATHER

Weather records for Lawes, 15km west of the survey area, show a mean annual rainfall of 780±183mm (83 years) with 70% falling in October through March (Cook & Russell, 1983; Willcocks & Young, 1991). Mean monthly maximum temperatures range from 20.3°C in July to 31.0°C in December, and mean monthly minimum temperatures from 5.6°C in July to 19.1°C in February. On average, light frosts (screen minimum 0.1 to 2.2°C) occur on 12.5 days and heavy frosts (screen minimum 0.0°C or lower) on 2.3 days per year.

Between 1980 and 1985 annual rainfall (June through May) ranged from 697mm to 951mm. Seasonal variability was high with 23mm in June through August 1982 and 419mm in December through February 1981-82. In most seasons rainfall was near or below average but in March through May 1983, and June through August 1983 and 1984, rainfall exceeded the average by over 50% (Leach & Hines, 1992). Mean maximum monthly temperatures were >1°C above average from August through November 1980, in February and March 1983, in December 1984 and in January 1985 and were >1°C below average from September through November 1984. Minimum temperatures were >1°C above average from November 1981 through January 1982 and from May through October 1983 and were >1°C below average in June and July 1982. From June through August there were 17 light, and five severe, frosts in 1982, 11 light frosts in 1981, six in 1980 but only two in both 1983 and 1984.

SURVEY PROCEDURES

From June 1980 through May 1985 we surveyed birds along a standard route once each season (20 standard surveys). (Seasons are as follows: winter, June through August; spring, September through November; summer, December through February; autumn, March through May). The 20km route, from Haigslea to Ashwell (Fig 1a), was traversed between 0730 and 1200h. At eight sites foot surveys of 10 to 45 minutes were conducted (Appendix 1); additional observations were made during the 5 to 15 minute periods driving between sites. Mid-afternoon surveys of Minden Dam and its surrounds (Fig. 1a) were included in the standard survey. Surveys were conducted by two to four observers who listed all species of bird seen or heard. The main habitats sampled were open farmland (predominantly pasture with isolated acacia and other trees), degraded softwood scrub remnants, woody weeds along roadsides and fencelines, and farm dams.

In addition to the 20 standard surveys, the Marburg district was visited on another 100 days, usually between about 0700h and 1600h. Surveys conducted on these days are referred to as 'other surveys' though some wholly or partly overlapped the route of standard surveys. There were 18 visits in both winter and summer periods, 32 in both spring and autumn periods, and between 17 and 26 each year. Most observations were made while walking or driving slowly along secondary roads and bush tracks. G.J.L. was on all surveys and was usually accompanied by one or more experienced observers. Appendix 2 lists the principal areas visited, the frequency of visits and the main habitats represented. These surveys differed from the standard surveys in that eucalypt associations were often traversed.

DATA COLLATION

The likelihood that a species was present in the survey area was estimated for each species as: (number of visits on which the species was observed)/(total number of visits). Values were calculated for each season of each year (seasonal frequency) and for each year (annual frequency). Mean Seasonal Frequency (MSF) and Mean Annual Frequency (MAF) were derived from the five years of observations. Data from the standard surveys and from the other surveys are treated separately. Species with MAF>0.2 in the standard surveys are referred to as *principal* species. The difference between maximum and minimum annual frequency is used as a measure of variation across years. It is more useful than standard error, especially when means are based on observations from only one or two years.

In this report, waterbirds include all species of Podicipedidae, Pelecanidae, Anhingidae, Phalacrocoracidae, Ardeidae, Ciconidae, Plataleidae, Anatidae, Rallidae, Jacanidae, Rostratulidae, Charadriidae, Recurvirostridae, Scolopacidae and Laridae. Other non-passerines are referred to as non-passerine landbirds.

RESULTS

SPECIES OBSERVED

One hundred and thirty one species were observed in the standard surveys and 190 in other surveys (Tables 1-3). All species observed in the standard surveys, except Rose-crowned Fruit-Dove and Forest Kingfisher, were also observed in the other surveys. Thus, the total number of

TABLE 2. Mean seasonal frequency (MSF) in standard surveys, and mean annual frequency (MAF) in standard surveys and other surveys, for non-passerine landbird species. Species order and abbreviations are as in Table 1.

Species	Standard surveys							Other surveys		
	Wi	Sp	Su	Au	MAF	Range	Years	MAF	Range	Years
Crested Pigeon	1.00	1.00	1.00	1.00	1.00	0.00	(5)	0.99	0.06	(5)
Australian Kestrel	1.00	1.00	1.00	1.00	1.00	0.00	(5)	0.85	0.17	(5)
Bar-shouldered Dove	1.00	0.80	1.00	1.00	0.95	0.25	(5)	0.98	0.06	(5)
Peaceful Dove	1.00	1.00	1.00	0.80	0.95	0.25	(5)	0.96	0.11	(5)
Pale-headed Rosella	1.00	1.00	0.80	1.00	0.95	0.25	(5)	0.93	0.29	(5)
Feral Pigeon	1.00	1.00	1.00	0.80	0.95	0.25	(5)	0.82	0.42	(5)
Spotted Turtle-Dove	0.80	0.80	1.00	0.80	0.85	0.25	(5)	0.81	0.35	(5)
Pheasant Coucal	0.80	0.80	1.00	0.80	0.85	0.50	(5)	0.66	0.34	(5)
Rainbow Bee-eater	0.80	0.80	0.60	1.00	0.80	0.75	(5)	0.81	0.41	(5)
Laughing Kookaburra	1.00	0.60	0.40	0.80	0.70	0.50	(5)	0.94	0.12	(5)
Scaly-breasted Lorikeet	0.80	0.60	0.40	0.40	0.55	0.50	(5)	0.67	0.36	(5)
Galah	0.40	0.80	0.60	0.20	0.50	0.50	(5)	0.49	0.24	(5)
Common Koel	-	0.80	1.00	-	0.45	0.25	(5)	0.30	0.24	(5)
Black-shouldered Kite	0.80	0.60	0.20	0.20	0.45	0.50	(5)	0.25	0.11	(5)
Sacred Kingfisher	0.20	0.80	0.60	-	0.40	0.25	(5)	0.51	0.18	(5)
Cockatiel	0.60	0.40	0.20	0.40	0.40	0.50	(5)	0.39	0.15	(5)
Wedge-tailed Eagle	0.80	0.20	-	0.60	0.40	0.50	(5)	0.26	0.23	(5)
Brown Falcon	0.40	0.20	0.20	0.40	0.30	0.25	(5)	0.27	0.34	(5)
Dollarbird	-	0.40	0.60	-	0.25	0.50	(4)	0.40	0.07	(5)
Brown Quail		0.40	0.40	0.20	0.25	0.75	(2)	0.15	0.44	(4)
Horsfield's Bronze-Cuckoo	-	0.60	0.40	-	0.25	0.50	(4)	0.11	0.17	(4)
Channel-billed Cuckoo	-	0.60	0.20	-	0.20	0.50	(3)	0.25	0.20	(5)
Brush Cuckoo	-	0.20	0.60	-	0.20	0.50	(3)	0.23	0.14	(5)
Brown Goshawk	0.40	0.20	-	0.20	0.20	0.50	(4)	0.09	0.12	(4)
Common Bronzewing	-	0.20	-	0.20	0.10	0.50	(1)	0.13	0.24	(4)
Azure Kingfisher	-	-	-	0.40	0.10	0.25	(2)	0.07	0.15	(3)
Pallid Cuckoo	-	0.40	-	-	0.10	0.25	(2)	0.04	0.18	(2)
Spotted Harrier	0.40	-	-	-	0.10	0.25	(2)	0.02	0.06	(2)
White-throated Needletail	-	-	0.40	-	0.10	0.25	(2)	0.02	0.06	(2)
Fan-tailed Cuckoo	-	0.20	-	-	0.05	0.25	(1)	0.26	0.19	(5)
Shining Bronze-Cuckoo	-	0.20	-	-	0.05	0.25	(1)	0.19	0.45	(4)
Stubble Quail	-	-	0.20	-	0.05	0.25	(1)	0.13	0.26	(3)
Rainbow Lorikeet	0.20	-	-	-	0.05	0.25	(1)	0.09	0.18	(4)
Australian Hobby	-	0.20	-	-	0.05	0.25	(1)	0.05	0.18	(3)
Peregrine Falcon	-	0.20	-	-	0.05	0.25	(1)	0.02	0.11	(1)
Grey Goshawk	-		0.20	-	0.05	0.25	(1)	0.01	0.05	(1)
Rose-crowned Fruit-Dove	-	-	0.20	-	0.05	0.25	(1)	-	-	
Forest Kingfisher	-	-	-	0.20	0.05	0.25	(1)	-	-	
Little Lorikeet	-	-	-	-	-	-		0.26	0.19	(5)
Whistling Kite	-	-	-	-				0.10	0.39	(4)
Blue-winged Kookaburra	-	-	-	-				0.07	0.22	(3)
Pacific Baza	-	-	-	-				0.06	0.11	(4)
Painted Button-quail	-	-	-	-	-	-		0.05	0.17	(2)
Emerald Dove	-	-	-	-	-	-		0.05	0.11	(3)
Collared Sparrowhawk	-	-		-	-	-		0.04	0.10	(3)
White-bellied Sea-Eagle	-	-	-	-	-	-		0.04	0.22	(1)
Marsh Harrier	-	-	-	-	-	-		0.04	0.17	(2)
Tawny Frogmouth	-	-	-	-	-	-		0.04	0.18	(2)
Australian Brush-turkey	-	-	-	-	-	-		0.03	0.06	(3)
Australian King-Parrot	-	-	-	-	-	-		0.03	0.11	(2)
Little Bronze-Cuckoo	-	-	-	-	-	-		0.03	0.06	(3)
Sulphur-crested Cockatoo	-	-	-	-	-	-		0.02	0.06	(2)
Musk Lorikeet	-	-	-	-	-	-		0.02	0.12	(1)
Crimson Rosella	-	-	-	-	-	-		0.02	0.08	(1)
Little Eagle	-	-	-	-	-	-		0.01	0.04	(1)
Topknot Pigeon	-	-	-	-	-	-		0.01	0.04	(1)
Brown Cuckoo-Dove	-	-	-	-	-	-		0.01	0.06	(1)
Wonga Pigeon	-	-	-	-	-	-		0.01	0.06	(1)
Southern Boobook	-	-	-	-	-	-		0.01	0.05	(1)
Barking Owl	-	-	-	-	-	-		0.01	0.05	(1)

species observed was 192. Tables 1, 2 & 3 separate observations for, respectively, waterbirds (44 species, 32 in standard surveys), non-passerine landbirds (60, 38) and passerines (88, 61). In each table species are ranked in descending order of MAF.

Seventy-seven species (41%, 30% and 47% of waterbirds, non-passerine landbirds and passerines, respectively) were observed every year in the standard surveys and 112 species (64%, 38% and 69%) in other surveys. Ninety-one species (55%, 35% and 52%) qualified as *principal* species.

Variation in Annual Frequency of Observation of Species

All species are classed according to variation in annual frequency in Table 4. In standard surveys, variation in frequency across years was low for 80 species (48 principal species). Variation was also low for 52 of these species (32 principal species) in the other surveys. In contrast, annual variation for Glossy Ibis, Yellow-billed Spoonbill, Hardhead, Black-winged Stilt, White-throated Gerygone, Zebra Finch and Pied Currawong was high in the other surveys. Seventeen species had high variation in annual frequency in standard surveys, but only Comb-crested Jacana and Common Myna were as variable in the other surveys. Most species that occurred only in the other surveys had low variation in annual frequency.

Variation in annual frequency among waterbirds, especially the shoreline species, was largely attributable to low frequencies in 1983-84.

In the standard surveys, annual frequencies of Pacific Heron decreased through the survey period ($P<0.05$) while those of Brown Quail increased ($P<0.05$). No consistent trends were detected across years for any other species observed in standard surveys. In other surveys, annual frequencies of eight species increased significantly through the survey period ($P<0.05$). However, the frequencies for Plumed Whistling-Duck, Grey Shrike-thrush, Weebill, White-throated Gerygone, Buff-rumped Thornbill, White-throated Honeyeater and Pied Currawong were also related to annual variation in the frequency of visits to eucalypt forest at Tallegalla, while that for Common Myna was related to frequency of visits to both Woolshed Creek Road and Prenzlau Swamp.

Because most species (131, 68%) showed little variation in frequency between years, and much of the variation for the remainder was correlated with the frequency of visits to specific habitats in different years, subsequent sections are concerned only with MAF and MSF values over the five years.

Mean Annual Frequency (MAF)

In standard surveys, 75% of waterbird and passerine species, but only 55% of non-passerine landbird species, were principal species (Tables 1-3). More of the waterbird (38%) and passerine species (39%) than of the non-passerine landbird species (21%) were among the birds observed most regularly, i.e. in over 80% of surveys.

In the other surveys, 57, 40 and 64% of waterbird, non-passerine landbird and passerine species, respectively, were observed in over 20% of surveys; 16 to 20% of the species in these three categories were observed in over 80% of surveys.

For most species, MAF was similar in standard and other surveys. All species with high MAF (>0.8) in standard surveys had an MAF of at least 0.5 in other surveys. Among species with intermediate MAF (0.21 to 0.80) in standard surveys, MAF in other surveys for Laughing Kookaburra, Grey Shrike-thrush, Speckled Warbler and Varied Triller was substantially greater (>0.2 units) and that for Royal Spoonbill, Black-fronted Plover, Fairy Martin, Richard's Pipit, Red-backed Fairy-wren, Chestnut-breasted Mannikin, Tawny Grassbird and Singing Bushlark was substantially lower. Fan-tailed Cuckoo, Leaden Flycatcher, White-throated Gerygone and Pied Currawong, with low MAF (0.1 or less) in standard surveys, had MAF substantially greater in other surveys. Little Lorikeet and seven passerines that were absent from standard surveys had intermediate MAF in other surveys.

No specific family, or guild, of waterbirds was consistently observed at either high or low MAF. Among non-passerine landbirds, ground feeding pigeons and doves, including two introduced species, had high MAF, contrasting with fruit-doves which were seldom observed. Several raptors also had low MAF, but in contrast the Australian Kestrel was always observed. Among passerines, several small species (e.g. Superb Fairy-wren, Yellow Thornbill and White-browed Scrubwren) had high MAF as did the much larger, and conspicuous, Australian Magpie and Torresian Crow.

Mean Seasonal Frequency (MSF)

Twenty-six species were observed in standard surveys in all seasons of all years and another 27

TABLE 3. Mean seasonal frequency (MSF) in standard surveys, and mean annual frequency (MAF) in standard surveys and other surveys, for passerine species. Species order and abbreviations are as in Table 1.

Species	Standard surveys							Other surveys		
	Wi	Sp	Su	Au	MAF	Range	Years	MAF	Range	Years
Willie Wagtail	1.00	1.00	1.00	1.00	1.00	0.00	(5)	1.00	0.00	(5)
Australian Magpie-lark	1.00	1.00	1.00	1.00	1.00	0.00	(5)	1.00	0.00	(5)
Australian Magpie	1.00	1.00	1.00	1.00	1.00	0.00	(5)	1.00	0.00	(5)
Torresian Crow	1.00	1.00	1.00	1.00	1.00	0.00	(5)	1.00	0.00	(5)
Superb Fairy-wren	1.00	1.00	1.00	1.00	1.00	0.00	(5)	0.99	0.06	(5)
Striped Honeyeater	1.00	1.00	1.00	1.00	1.00	0.00	(5)	0.99	0.05	(5)
Noisy Miner	1.00	1.00	1.00	1.00	1.00	0.00	(5)	0.97	0.06	(5)
Black-faced Cuckoo-shrike	1.00	1.00	1.00	1.00	1.00	0.00	(5)	0.96	0.12	(5)
Silvereye	1.00	1.00	1.00	1.00	1.00	0.00	(5)	0.96	0.10	(5)
Lewin's Honeyeater	1.00	1.00	1.00	1.00	1.00	0.00	(5)	0.95	0.12	(5)
Double-barred Finch	1.00	1.00	1.00	1.00	1.00	0.00	(5)	0.95	0.11	(5)
Pied Butcherbird	1.00	1.00	1.00	1.00	1.00	0.00	(5)	0.95	0.15	(5)
Common Starling	1.00	1.00	1.00	1.00	1.00	0.00	(5)	0.94	0.21	(5)
Figbird	1.00	1.00	1.00	1.00	1.00	0.00	(5)	0.85	0.24	(5)
Welcome Swallow	1.00	1.00	1.00	1.00	1.00	0.00	(5)	0.78	0.38	(5)
Golden-headed Cisticola	1.00	1.00	1.00	1.00	1.00	0.00	(5)	0.78	0.30	(5)
Zebra Finch	1.00	1.00	1.00	1.00	1.00	0.00	(5)	0.74	0.53	(5)
Grey Butcherbird	0.60	1.00	1.00	1.00	0.90	0.25	(5)	0.86	0.41	(5)
Yellow-rumped Thornbill	0.80	0.80	1.00	1.00	0.90	0.25	(5)	0.57	0.23	(5)
Yellow Thornbill	1.00	0.60	1.00	0.80	0.85	0.25	(5)	0.93	0.06	(5)
Rufous Whistler	0.80	1.00	0.80	0.80	0.85	0.50	(5)	0.91	0.29	(5)
White-browed Scrubwren	1.00	0.80	0.60	1.00	0.85	0.50	(5)	0.75	0.13	(5)
Clamorous Reed-Warbler	0.60	1.00	1.00	0.80	0.85	0.50	(5)	0.69	0.31	(5)
House Sparrow	0.80	0.80	1.00	0.80	0.85	0.50	(5)	0.63	0.17	(5)
Grey-crowned Babbler	0.80	0.60	0.80	1.00	0.80	0.25	(5)	0.68	0.22	(5)
Fairy Martin	0.80	1.00	1.00	0.40	0.80	0.50	(5)	0.55	0.30	(5)
Eastern Whipbird	1.00	0.80	0.60	0.60	0.75	0.50	(5)	0.70	0.48	(5)
Brown Honeyeater	1.00	1.00	0.60	0.40	0.75	0.50	(5)	0.66	0.22	(5)
Richard's Pipit	1.00	0.60	0.80	0.60	0.75	0.50	(5)	0.34	0.52	(5)
Red-backed Fairy-wren	0.80	1.00	0.60	0.60	0.75	0.75	(5)	0.34	0.29	(5)
Striated Pardalote	1.00	0.80	-	0.80	0.65	0.25	(5)	0.80	0.35	(5)
Olive-backed Oriole	0.40	0.80	0.80	0.40	0.60	0.75	(5)	0.50	0.20	(5)
Rufous Fantail	-	1.00	0.80	0.40	0.55	0.50	(5)	0.55	0.25	(5)
Grey Shrike-thrush	0.20	0.60	0.40	0.80	0.50	1.00	(5)	0.83	0.29	(5)
White-backed Swallow	0.40	0.80	0.20	0.60	0.50	0.75	(4)	0.64	0.36	(5)
Eastern Yellow Robin	0.60	0.40	0.40	0.60	0.50	0.50	(5)	0.47	0.30	(5)
Speckled Warbler	0.40	0.20	0.60	0.60	0.45	0.75	(5)	0.74	0.32	(5)
Mistletoebird	0.20	0.60	0.60	0.40	0.45	0.50	(5)	0.58	0.47	(5)
Grey Fantail	1.00	-	-	0.80	0.45	0.25	(5)	0.47	0.15	(5)
Chestnut-breasted Mannikin	0.20	0.40	0.80	0.40	0.45	0.75	(4)	0.23	0.25	(5)
Tawny Grassbird	-	0.40	1.00	0.40	0.45	0.50	(5)	0.12	0.24	(4)
Varied Triller	0.20	0.40	0.20	0.40	0.30	0.50	(3)	0.61	0.60	(5)
Common Myna	0.20	0.20	0.40	0.40	0.30	0.75	(3)	0.37	0.68	(5)
Singing Bushlark	-	-	0.80	0.40	0.30	0.25	(5)	0.08	0.24	(4)
Golden Whistler	0.80	-	-	0.20	0.25	0.00	(5)	0.37	0.20	(5)
Variegated Fairy-wren	0.40	0.60	-	-	0.25	0.50	(3)	0.32	0.41	(5)
White-winged Triller	-	0.60	0.20	-	0.20	0.25	(4)	0.08	0.15	(3)
Black-faced Monarch	-	0.20	0.20	0.20	0.15	0.50	(2)	0.13	0.26	(4)
Tree Martin	-	-	0.40	0.20	0.15	0.50	(2)	0.07	0.28	(2)
Pied Currawong	0.40	-	-	-	0.10	0.25	(2)	0.50	0.71	(5)
Spangled Drongo	0.20	-	-	0.20	0.10	0.25	(2)	0.29	0.34	(5)
Restless Flycatcher	0.20	0.20	-	-	0.10	0.25	(2)	0.12	0.41	(3)
Nutmeg Mannikin	0.20	-	-	0.20	0.10	0.50	(1)	0.11	0.24	(3)
Eastern Spinebill	0.20	-	-	0.20	0.10	0.25	(2)	0.10	0.24	(4)
White-throated Gerygone	-	0.20	-	-	0.05	0.25	(1)	0.69	0.60	(5)
Leaden Flycatcher	-	0.20	-	-	0.05	0.25	(1)	0.32	0.37	(5)
Yellow-faced Honeyeater	-	-	-	0.20	0.05	0.25	(1)	0.21	0.18	(5)
Little Friarbird	-	0.20	-	-	0.05	0.25	(1)	0.20	0.37	(5)
Red-browed Firetail	-	0.20	-	-	0.05	0.25	(1)	0.17	0.21	(5)
Rose Robin	-	-	-	0.20	0.05	0.25	(1)	0.12	0.17	(5)
Little Cuckoo-shrike	0.20	-	-	-	0.05	0.25	(1)	0.01	0.06	(1)
White-throated Honeyeater	-	-	-	-	-	-		0.66	0.76	(5)
Buff-rumped Thornbill	-	-	-	-	-	-		0.47	0.83	(5)

TABLE 3. Cont. Species order and abbreviations are as in Table 1.

Species	Standard surveys							Other surveys		
	Wi	Sp	Su	Au	MAF	Range	Years	MAF	Range	Years
Weebill	-	-	-	-	-	-		0.44	0.65	(5)
Scarlet Honeyeater	-	-	-	-	-	-		0.41	0.30	(5)
White-throated Treecreeper	-	-	-	-	-	-		0.39	0.49	(5)
Varied Sittella	-	-	-	-	-	-		0.30	0.43	(5)
Spotted Pardalote	-	-	-	-	-	-		0.23	0.23	(5)
Cicadabird	-	-	-	-	-	-		0.18	0.14	(5)
Jacky Winter	-	-	-	-	-	-		0.18	0.25	(5)
Noisy Friarbird	-	-	-	-	-	-		0.12	0.28	(4)
White-breasted Woodswallow	-	-	-	-	-	-		0.06	0.11	(3)
Rufous Songlark	-	-	-	-	-	-		0.05	0.18	(2)
Ground Cuckoo-shrike	-	-	-	-	-	-		0.03	0.12	(1)
Little Shrike-thrush	-	-	-	-	-	-		0.02	0.06	(2)
Dusky Woodswallow	-	-	-	-	-	-		0.02	0.10	(1)
Regent Bowerbird	-	-	-	-	-	-		0.02	0.12	(1)
Yellow-eyed Cuckoo-shrike	-	-	-	-	-	-		0.01	0.06	(1)
Scarlet Robin	-	-	-	-	-	-		0.01	0.04	(1)
Crested Shrike-tit	-	-	-	-	-	-		0.01	0.05	(1)
Satin Flycatcher	-	-	-	-	-	-		0.01	0.04	(1)
Little Grassbird	-	-	-	-	-	-		0.01	0.06	(1)
Brown Songlark	-	-	-	-	-	-		0.01	0.06	(1)
Brown Gerygone	-	-	-	-	-	-		0.01	0.06	(1)
Blue-faced Honeyeater	-	-	-	-	-	-		0.01	0.06	(1)
Fuscous Honeyeater	-	-	-	-	-	-		0.01	0.06	(1)
Plum-headed Finch	-	-	-	-	-	-		0.01	0.06	(1)
Satin Bowerbird	-	-	-	-	-	-		0.01	0.04	(1)

in all seasons of at least three years (i.e. MSF of 0.6 or higher). MSF values for another 25 species observed in standard surveys varied from lows of 0.0 or 0.2 to highs of 0.6 or 0.8, respectively, or higher; for eight of them minimum MSF on other surveys were always intermediate (>0.2) and, thus, only 17 species showed clear differences in seasonal presence. Another 11 species that were either missing from standard surveys, or observed at low MAF (0.2 or less) on those surveys, had minimum MSF<0.2 and a range >0.3 in other surveys, indicating that they also differed in seasonal presence. MSF in other surveys for Darter (range 0.0 to 0.28) and Black-faced Monarch (0.0 to 0.22) were consistent with those in standard surveys, confirming the small differences in seasonal presence. Approximate dates on which these 30 species with clear differences in MSF were present are shown in Fig. 2.

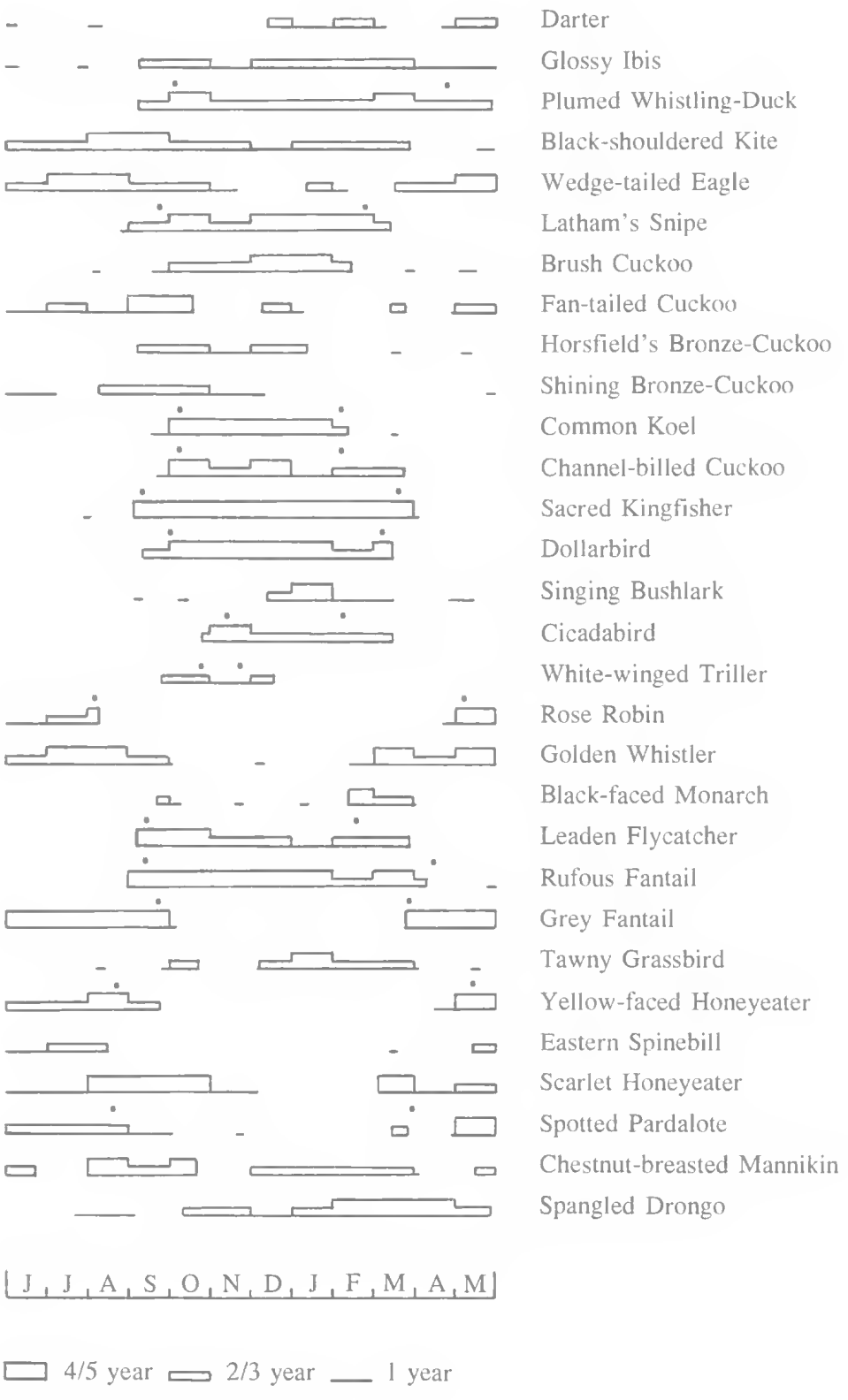
DISCUSSION

The Value of Information on Frequency of Observation

Knowledge of ways in which abundance of bird species is influenced by land use is essential to wildlife management. For a limited range of habitats, e.g. commercial forests, this can be readily obtained in structured, systematic surveys. Such surveys have not been done over farming landscapes, and management decisions depend substantially on opportunistic information.

The standard survey adequately monitored changes in abundance of individual species within seasons, but inferences on the relative abundance of different species, and of individual species between seasons, need to take account of differences in detectability (Emlen, 1971; Davies, 1984; Recher, 1988). Estimates of abundance also need to be based on several years of survey (Rice et al., 1983). The variable climate in Australia, particularly in southeast Queensland, makes this even more important. However, variation in frequency between years for most species in the Marburg district was low. The major exceptions were waterbirds that move nomadically in response to inland rainfall (Gosper et al., 1983; Woodall, 1985), and it is generally more useful to relate their frequency of occurrence to proximate causal factors than to determine unadjusted long-term mean frequencies. The wide variation in annual frequency for some land birds was associated with proportion of visits to a eucalypt association, reflecting restricted use of habitat in the district and the limitations of the other surveys.

Notwithstanding the preceding comments, the combination of seasonally balanced standard surveys with a larger number of other surveys pro-


Darter
Glossy Ibis
Plumed Whistling-Duck
Black-shouldered Kite
Wedge-tailed Eagle
Latham's Snipe
Brush Cuckoo
Fan-tailed Cuckoo
Horsfield's Bronze-Cuckoo
Shining Bronze-Cuckoo
Common Koel
Channel-billed Cuckoo
Sacred Kingfisher
Dollarbird
Singing Bushlark
Cicadabird
White-winged Triller
Rose Robin
Golden Whistler
Black-faced Monarch
Leaden Flycatcher
Rufous Fantail
Grey Fantail
Tawny Grassbird
Yellow-faced Honeyeater
Eastern Spinebill
Scarlet Honeyeater
Spotted Pardalote
Chestnut-breasted Mannikin
Spangled Drongo
J J A S O N D J F M A M
4/5 year
2/3 year
1 year

vides adequate baseline information on seasonal and annual frequency of species for habitat management. The standard surveys are repeatable, and continue, enabling long-term changes to be monitored and compared with similar information from elsewhere (e.g. the Australian Bird Count; Ambrose, 1989). Although it would be impracticable to precisely repeat the other surveys, their number and broadly specified representation of habitats ensures a useful baseline to which changes can be related.

Frequency of Observation of Species

Waterbirds. Most of the principal waterbirds observed in the Marburg district (Table 1) are widely distributed in Australia, with 17 species occurring in over 40% of 1°grid squares (Blakers et al., 1984). Those with more restricted distribution include Cattle Egret, Intermediate Egret, Plumed Whistling-Duck, Dusky Moorhen, Purple Swamphen and Latham's Snipe. In contrast, some widespread species such as Australian Pelican, Great Cormorant and Pied Cormorant were seldom observed, even though their relative frequencies were greater than 60% in annual one-day counts for the region within 80km of Brisbane between 1972 and 1983 (Woodall, 1985). Twenty principal species were also common in northeast NSW. (Gosper, 1981; Gosper et al., 1983), with the Maned Duck the conspicuous exception.

The Marburg district, like the whole of southeast Queensland (Woodall, 1985) and northeast NSW. (Gosper, 1981; Gosper et al., 1983) is clearly rich in waterbirds. It supports many more species than regions inland of the Great Divide (Whitmore et al., 1983; Crossman & Reimer, 1986). Rural residential settlement has increased the number of dams to about 3 per km^2(see Queensland Dept Mapping and Survey, Marburg Topographic Map 9442-44). Although many dams are small and lack habitat diversity (G.J. Leach, unpublished data), they supplement older, and usually larger, dams and ephemeral shallow swamps which provide more diverse habitat (Braithwaite, 1975; Leach & Hines, 1992; Wilkinson and Schwenke, 1992). Absence of major reservoirs probably restricts deep water feeders such as Australian Pelican and the large cormorants.

The range in annual frequency was generally wider for waterbird species than for landbirds with the same MAF. Lower frequency of shoreline species in 1983-84 coincided with the end of a widespread southeast Australian drought, enabling them and birds of open water, e.g. cormorants and most ducks, to disperse inland, west of the Great Divide (Woodall, 1985; Leach & Hines, 1992). In contrast higher annual frequencies for several species occurred in the drier 1980-81 and 1982-83 years.

Non-passerine landbirds. Eleven of the principal non-passerine landbirds (Table 2) are widely distributed in Australia and the remaining 10 species occur in at least 11% of 1°grid squares (Blakers et al., 1984). Among the most frequently observed, Spotted Turtle-Dove, Peaceful Dove and Cockatiel were better represented at Marburg than in surrounding districts.

The principal species are birds of open country, the 'edge' between woody vegetation and open country, or farmlands. Few were numerous and five with a MAF of 0.5 or higher were ground-feeding pigeons and three were parrots. The Feral Pigeon, Spotted Turtle-Dove, Crested Pigeon and Galah were commensal with farming, and their abundance probably reflects the intensity of small-scale cropping, whereas the Peaceful Dove and Bar-shouldered Dove appear to depend on softwood scrub remnants. Among remaining species with MAF of 0.5 or higher, Australian Kestrel and Rainbow Bee-eater hunt over open country and contrast with Scaly-breasted Lorikeet, Pale-headed Rosella and Laughing Kookaburra utilising open-forest/woodland and the Pheasant Coucal using dense scrub and/or rank grass. Sacred Kingfisher was the only species with MAF>0.5 in other surveys that had MAF<0.5 in standard surveys, probably reflecting its preference for the open eucalypt forest with many termitaria for nest sites.

The most notable feature of the non-passerine landbirds was that half of them were observed on 5% or fewer visits, yet none are rare in southeast Queensland (Roberts, 1979). They included several raptors and parrots. The group also included the fruit-doves usually associated with closed-forest or softwood scrub, even though the district has many, isolated, *Ficus* spp. which produce heavy crops of fruit (Leach & Hines, 1987). The remnants of low closed-forest may be too small, too degraded, too isolated from extensive rainfor-

FIG. 2. Periods when species with substantial differences in MSF (see text) were present. Continuous lines/blocks join observations at closer than 4-week intervals, based on combined observations over 5 years. Number of years when species were present in each month and single observations are shown. Mean dates of arrival and departure of strongly seasonal migrants are also shown (●).

TABLE 4. The numbers of principal and non-principal species in standard surveys, and of species observed only in other surveys, classed according to low, medium and high variation in annual frequency. For standard surveys low, medium and high variation are represented by values of 0.0 or 0.25, 0.5, and 0.75 or 1.0 respectively; for other surveys the corresponding values are <=0.25, 0.26 to 0.5, and >0.5 respectively. The numbers of species with MAF <=0.20 in other surveys are shown in parentheses.

Range in annual frequency		Water-birds	Non-Passerines landbirds	Passerines	Total
Standard surveys	Other surveys				
Principal species					
Low	Low	6	6	20 (1)	32 (1)
"	Medium	5	4	4	13
"	High	2	0	1	3
Medium	Low	1	7 (1)	5 (1)	13 (2)
"	Medium	1	2	7	10
"	High	2	0	2	4
High	Low	0	0	2	2
"	Medium	6	2 (1)	4	12 (1)
"	High	1	0	1	2
Sub-total		24	21 (2)	46 (2)	91 (4)
Non-principal species					
Low	Low	3 (3)	11 (10)	6 (5)	20 (18)
"	Medium	0	4 (2)	4 (2)	8 (4)
"	High	2 (1)	0	2	4 (1)
Medium	Low	2 (2)	2 (2)	1 (1)	5 (5)
"	Medium	0	0	2 (2)	2 (2)
"	High	0	0	0	0
High	Low	0	0	0	0
"	Medium	1 (1)	0	0	1 (1)
"	High	0	0	0	0
Sub-total		8 (7)	17 (14)	15 (10)	40 (31)
Species observed on only the other surveys					
—	Low	10 (10)	21 (20)	20 (19)	51 (49)
—	Medium	1 (1)	1 (1)	4 (1)	6 (3)
—	High	1 (1)	0	3	4 (1)
Sub-total		12 (12)	22 (21)	27 (20)	61 (53)
Total		44 (19)	60 (37)	88 (32)	192 (88)

est and/or naturally floristically unsuitable for other than limited opportunistic exploitation by fruit-doves. Fruit-doves were only occasionally observed immediately following European settlement at Murphy's Creek, 50km west (Lord, 1956), but whether they were more prominent in the more extensive softwood scrub of the Marburg District (Elsol, 1991) cannot be ascertained.

Passerines. Twenty-three principal passerines (Table 3) have a wide Australian distribution, while five were reported from <11% of 1°grid squares (Blakers et al., 1984). The latter include species associated with closed-forest (Varied Triller, Eastern Whipbird and Lewin's Honeyeater) or rank grassland (Tawny Grassbird) and the Common Myna. Nine species with low MAF (0.2 or less) (Tree Martin, White-winged Triller, Jacky Winter, Restless Flycatcher, Rufous Songlark, Brown Songlark, Weebill, Varied Sittella and White-breasted Woodswallow) are widely distributed in Australia. Nine non-principal species are restricted to <11% of the Australian 1° grid squares, with Yellow-eyed Cuckoo-shrike, Black-faced Monarch, Little Cuckoo-shrike, Brown Gerygone, Satin Bowerbird and Regent Bowerbird associated with closed-forest. Species observed more frequently than in neighbouring grid squares include Grey-

crowned Babbler, Superb Fairy-wren, Yellow Thornbill, Speckled Warbler, Striped Honeyeater and Zebra Finch.

Passerines are clearly the most important component of the avifauna, both in terms of species number (Leach & Hines, 1987) and frequency of observation (Table 3). Thirty-three of the species listed in Table 3 were observed in roadside remnant vegetation in summer, including 31 principal species (Leach & Recher, 1993). The six most numerous species in roadside remnants, namely Silvereye, Superb Fairy-wren, Yellow Thornbill, Double-barred Finch, Red-backed Fairy-wren and Lewin's Honeyeater had MAF of 0.75 or more.

Cicadabird, Weebill, White-throated Gerygone, Buff-rumped Thornbill, Varied Sittella, White-throated Treecreeper, White-throated Honeyeater and Spotted Pardalote, with much higher MAF in other surveys than in standard surveys, are largely restricted to the eucalypt associations (G.J. Leach, unpublished data), corroborated by correlation of their MAF with proportion of visits to eucalypt stands at Tallegalla. Other differences in MAF between surveys also reflect the proportion of visits to eucalypt associations, e.g. Yellow-faced Honeyeater and Pied Currawong.

Among species with greater MAF in standard surveys than in other surveys, the narrow range in annual frequencies for Singing Bushlark, Tawny Grassbird and Yellow-rumped Thornbill confirms their localised distribution. This reflects preference for open country, rank grassland, and close-grazed or mown grassland around isolated trees, respectively (Leach & Hines, 1987). Larger ranges in annual frequency contribute to the difference in MAF between surveys for Fairy Martin, Richard's Pipit and Red-backed Fairy-wren, but at least part of the difference for the first two is likely to reflect preference for open habitat. The difference for the Red-backed Fairy-wren may be related to its abundance in roadside vegetation (Leach & Recher, 1993) and use of swamp grasslands (Leach & Hines, 1987).

The introduced Common Myna colonized the district from the west during this survey, reaching the eastern boundary in 1982 (Leach & Hines, 1987). Correlations with visits to Woolshed Creek Road and Prenzlau, in the west, probably reflect marginally longer colonization in these areas.

A wide range of families and feeding strategies are represented among principal passerines. Approximately half the species primarily use open, or disturbed, habitats (Schodde & Tidemann, 1986). Exceptions associated with closed-forest/softwood scrub include Varied Triller, Grey Shrike-thrush, Rufous Fantail, Eastern Whipbird, White-browed Scrubwren, Yellow Thornbill, Silvereye, Lewin's Honeyeater and Figbird (Howe, 1986; Leach & Recher, 1993).

Species using rainforest patches in northern NSW were grouped according to size of patch occupied (Howe, 1986). The first 21 species listed in Table 3 were not in the more specialised rainforest groups. The Rufous Fantail and White-throated Treecreeper were placed in a group requiring patches larger than 2.5 ha. However, the Rufous Fantail was common in narrow roadside remnants at Marburg (Leach & Recher, 1993), whereas the White-throated Treecreeper was mainly observed in open eucalypt forest on other surveys. Several species occurring in small and large rainforest patches, but predominantly the latter, were observed in roadside remnants at Marburg, indicating that habitat use differs from that in northern NSW. An explanation for the differences may be that abundant Lantana (*Lantana camara*) and other woody weeds provide a more effective linkage between small remnant patches for many bird species than in northern NSW (Lynch, 1987; Lynch & Saunders, 1991; McIntyre & Barrett, 1992; Leach & Recher, 1993). Because the diversity and abundance of passerines may be more vulnerable to intensified land use than their current status indicates (cf. Recher & Lim, 1990), it may become especially important to retain, and where possible regenerate, native woody vegetation if woody weeds are substantially controlled and cleared.

Seasonal Migrants

Surveys were sufficiently frequent to provide approximate dates of arrival and departure of migrant species (Fig 2). Some species are clearly summer (e.g. Latham's Snipe, Common Koel, Leaden Flycatcher and Rufous Fantail) or winter (e.g. Rose Robin, Grey Fantail and Yellow-faced Honeyeater) visitors, with little variation between years in dates of first or last observation. Some tended to be absent from the district for only a very short period (e.g. Black-shouldered Kite and Wedge-tailed Eagle) while White-winged Triller was present for only a short period. Others (e.g. Scarlet Honeyeater and Spotted Pardalote) were consistently observed at disjunct intervals. Several migrants consistently arrived in late September, e.g Common Koel and Dollarbird, but dates of last observation were more variable.

Information for southeast Queensland, mainly limited to honeyeaters at Wellington Point (Robertson, 1958, 1965; Robertson & Woodall, 1983), is significantly augmented. Features of special interest are the small period of overlap between the Rufous Fantail and the Grey Fantail in September and March/early April, the short winter presence of the Rose Robin, the short visit of the White-winged Triller for breeding (G.J. Leach, unpublished data), and migration patterns in the honeyeaters. Low MSF in summer and/or autumn for some otherwise relatively common raptors indicates that further study is necessary to establish if this is the result of seasonal movement, or is associated with behavioural changes that affect detectability while breeding. Latham's Snipe is the only truly seasonal migrant among the principal waterbirds because Plumed Whistling-Duck is a winter resident in the neighbouring grid square (Leach & Hines, 1987). Information for other waterbirds, e.g. Black Swan and Glossy Ibis, reflects nomadic movements.

Summer presence of the Rufous Fantail in the Marburg district agrees with observations in northeast NSW. (Cameron, 1985). However, the Grey Fantail was more numerous in summer than winter in NSW. Roberts (1979) remarks that Grey Fantails are resident in southeast Queensland with an increase in numbers in winter. Our data shows that it is not resident in all habitats, possibly because different races may occupy different habitats (Cameron, 1985). Mist netting since 1988 has shown that small numbers of both species are present outside the dates in Fig. 2 (G. R. Anderson & G.J. Leach, unpublished data), suggesting that more monitoring of their movements is necessary.

Observations for the Yellow-faced Honeyeater and Eastern Spinebill (Fig. 2) closely match those of Robertson and Woodall (1983). The continuous presence of Scarlet Honeyeaters at Wellington Point from March through September contrasts with its frequent absence through midwinter in the Marburg district where it, and also the Spotted Pardalote, appear to be seasonal migrants responding to local variation in availability of food.

CONCLUSIONS

The Marburg district supports a rich diversity of bird species, with waterbirds and passerines generally better represented than non-passerine landbirds. The diversity is sustained by the wetlands, remnants of brigalow softwood scrub, eucalypt open-forest and the woody weeds interspersed through the farmlands. The survey has established a robust database which will allow changes in mean annual and seasonal frequency of bird species to be detected. The information should be used to guide management of these diverse habitats.

While the avifauna (with the exception of most non-passerine landbirds) is well-adapted to the existing matrix of terrestrial and wetland habitats, additional human settlement and intensification of land use may lead to a breakdown of this matrix. Regular monitoring is vital. Maintenance of the present diversity and abundance of birds will require management strategies aimed at retention and better management of existing native woody vegetation, and re-vegetation with appropriate native species wherever practicable.

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APPENDIX 1 Details of localities in the standard survey which were surveyed on foot.

Location	Grid Ref.	Duration (mins)	Habitats			
			Roadside	Paddocks	Dams	Other
Haigslea (School)	MQ631500	45	T(1,A,B), G(s-r).	T(1,A), G(s), C(1).	M1, M2 & M3 (s) + 1(s, silted with *Typha* sp. and adjacent *Schinus terebinthifolia*).	School and church grounds. T(2, native & exotic), G(s).
Haigslea	MQ618495	20	G(r).	T(1,A), G(r), C(1).	M4(m) + 1(m).	
MT Marrow	MQ627481	20	T(2,S,A), W(2,L), G(r).	T(2,S,A), W(2,L), G(s-r).	M5(s).	Road metal quarry south of road.
Malabar	MQ609483	15	T(1,A), W(1,C,L), G(r).	T(1,A,B), W(1,L,C), G(m-r).	M6(1).	
Malabar	MQ609477	30	T(2,S,A,B), W(2,L) G(r).	T(1,S,A), W(1,L), G(m-s).		Dis-used sand quarry south of road. Cliffs used by hole-nesting species (see Leach and Hines, 1987).
Tallegalla (Railway dam)	MQ577467	10	T(1,A), W(1,C,L), G(m-r).	T(1,A,B), W(1,L), G(s).	1(m, covered with Water hyacinth, *Eichhornia crassipes*).	
Tallegalla (The Bluff)	MQ550464	30	T(2,S,A), W(2,L), G(m-r).	T(2,S,A), W(2,L), G(s-m).	2(s, often empty)	Three large *Ficus* spp. at this site.
Ashwell	MQ561446	20	T(2,S,A,B), W(2,L), G(r).	T(S,B,E,A), W(2,L), G(s-r).		Small creek through site
Minden Dam	MQ548522	15	T(1,A,S), G(s-r).	T(2,E,B,S), G(s-r).	1(m - Leach & Hines, 1992).	Mid-afternoon.

1. Grid References for Marburg (9442-44) and Haigslea (9442-41) 1:25 000 Topographic Maps.
2. Vegetation:
T - trees; 2, 1 - more than 5, and 1 to 5, respectively >8m tall in vicinity. Principal trees are Brigalow (*Acacia harpophylla*) (B), other acacia spp. (A), softwood species (S, see Leach & Hines, 1987), and eucalypts (E).
W - woody weeds; 2 - extensive thickets, 1 - isolated clumps; species include lantana (*Lantana camara*) (L) and Wait-a-while (*Caesalpinia decapetala*) (C).
G - grass; s - grazed short, m - medium grazed to about 500mm tall, r - rank, often not grazed and over 1000mm tall.
C - cultivated land nearby, <20% of total area within 500m of road.
Additional details of roadside vegetation on parts of the standard route are in Leach & Recher (1993).
3. Dams - those prefixed 'M' are described in Leach (1994). Minden is described in Leach & Hines (1992).
Dams are described as large (l, >15 000m^2 maximum surface area), medium (m, 5000 to 15 000m^2) or small (s, <5000m^2).

APPENDIX 2 Principal areas visited in the 100 non-standard surveys.

Locality	Number of visits	Habitats	Remarks
Haigslea/Malabar/ MT Marrow.	92[1]	As first five sites on standard route, plus extra softwood remnants.	82 to 100% of visits each year.
Schumans Road.	71[2]	Well-conserved lengths of softwood scrub gallery, about 7m wide (Leach & Recher, 1993).	24% of visits in 1980-81; 68 to 100% thereafter.
The Bluff, Tallegalla	19	See App.1.	10 to 29% of visits each year.
Woolshed Creek Road - East.	83[2]	Lengths of softwood scrub gallery, about 8m wide plus small creek and gallery of *Melaleuca bracteata*.	65% of visits in 1980-81, progressively increasing to 100% in 1984-85.
Woolshed Creek Road - West.	78[2]	Eucalptus open-forest (especially *E. maculata*) with woody weeds and grazed grass understorey (Leach & Hines, 1987).	47% of visits in 1980-81, increasing through 69, 84, 90 and 100% in following years.
Glamorgan Vale - MT Stradbroke.	9	As Haigslea/Malabar/MT Marrow, plus more extensive areas of relatively intact Brigalow-softwood scrub.	29% of visits in 1980-81, 15% in 1981-82, none subsequently.
Prenzlau Swamp[3].	36	Shallow ephemeral swamp (Leach & Hines, 1987).	First visited in March 1981; 18% of visits in 1980-81, increasing through 23, 32, 40 and 72% in following years.

(1) Censuses of farm dams (Dams M1 to M6, see Appendix 1) were major objectives on 14 of these visits.
(2) Transect censuses carried out on 12 of these days and rolling bird surveys (Cullen, 1980) on another 40 days. Five rolling bird surveys were completed in spring and autumn of each of the last four years, substantially contributing to the discrepancy in number of visits between seasons.
(3) Prenzlau Swamp. Extensive open water (c.100ha) in March 1981, reduced by 80% by October 1981 and almost no open water by October 1982. Flooded in May 1983 and extensive open water thereafter apart from early summer 1984-85.

CRAB ISLAND REVISITED : REASSESSMENT OF THE WORLD'S LARGEST FLATBACK TURTLE ROOKERY AFTER TWELVE YEARS

COLIN J. LIMPUS, P. J. COUPER AND K. L. D. COUPER

Limpus, C.J., Couper, P.J. & Couper, K.L.D. 1993 06 30 : Crab Island revisited: reassessment of the world's largest Flatback Turtle rookery after twelve years. *Memoirs of the Queensland Museum* 33(1):277-289. Brisbane. ISSN 0079-8835.

Crab Island in northeastern Gulf of Carpentaria supports the largest nesting population of *Natator depressus*, a marine turtle endemic to the Australian continental shelf, and low density nesting by *Eretmochelys imbricata*. The reproductive status of the Flatback Turtle, *Natator depressus*, at Crab Island, is reassessed after 12 years based on a survey conducted during high density nesting in July 1991. *N. depressus* hatchling productivity from the island continues to be high. The characteristic small size of nesting females and egg diameters of *N. depressus* that breed in the Crab Island region suggests that this population is a different breeding unit from that of the southern Great Barrier Reef. The feeding areas supplying turtles to the Crab Island region rookeries extend as far north as southern Irian Jaya. □ *Natator depressus, Eremochelys imbricata, Crab Island, Queensland, Australia, nesting, hatchling productivity, conservation status.*

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Crab Island, in the north eastern Gulf of Carpentaria, supports the largest recorded nesting aggregation of Flatback Turtles, *Natator depressus* (Limpus & Parmenter, 1986). *N. depressus* is almost totally confined to the Australian continental shelf and its breeding is restricted to Australia (Limpus et al. 1988). The biology of marine turtle populations breeding on Crab Island was reviewed by Limpus et al. (1983a) based on field surveys of the nesting turtles in 1970-1979. Because the status of this significant turtle breeding population had not been reassessed since that time, a study to redescribe the reproductive biology of the Crab Island turtles after a 12 year interval was undertaken in July 1991, during the high density nesting period identified in previous studies (Limpus et al. 1983a).

METHODS

A two person team camped on Crab Island during 6-22 July 1991 (P.J.C. and K.L.D.C.). The western (ocean) beach of the island was measured along the spring high tide level and subdivided into eleven numbered sectors (each 500m long) from south to north (Fig. 1) using a pedometer. All data recorded along the island were scored by beach sector. The beach width within sectors 1-10 was measured from the spring high tide level to the crest of the seaward dune adjacent at each sector mark. These were the sectors in which all turtle nesting activity occurred. On arrival, the team counted all existing turtle tracks by species, without attempting to age the tracks. A single track included both the emergence and return crawl of a nesting turtle. All tracks were crossed off in the sand above the high tide mark as they were counted so that previously recorded tracks could be recognised. Thereafter, a track census was conducted daily: all turtle tracks and nests from which hatchlings had emerged from the previous night were counted by species along the western beach. Because two persons could not monitor the nesting behaviour of all turtles ashore for a night along 6km of beach, a subset of the beach sectors (4 to 6) was selected for nightly measurement of nesting success of each turtle. Potential predators of the turtles, their eggs or hatchlings were identified and quantified where possible. This included counting of crocodile and bird tracks. Turtles were recorded in the waters adjacent to the nesting beach during the daily census of tracks on those days when the weather was relatively calm. As well, a male turtle was captured by 'beach jumping' (cf. Limpus & Reed, 1985).

Opportunistic tagging of nesting female turtles occurred when volunteer members of the Queensland Turtle Research Project visited Crab Island (28 December 1989 and 15-17 January, 1991) and the south beach at the mouth of the Jardine River on the mainland, 14km from Crab Island (29 December 1987). Adult turtles were tagged using